4. The Terms of Bioplastology.

By Professor A. Hyatt, Boston, Mass., U.S.A.

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I have written the following paper which is an abstract of one read before the Boston Society of Natural History, entitled »Bioplastology and the related Branches of biologic Research«, partly in reply to a critical paper by Mr. Buckman and Mr. Bather and partly as a new contribution in the same field.

I propose to describe in a brief way the four different lines of research which are usually designated by the popular terms growth, heredity, acquired characteristics, and the correlations of development of the individual (ontogeny) with the evolution of the group to which it belongs (phylogeny). The object being to explain the relations of these to each other and to give adequate reasons for the substitution of scientific terms for the popular names heretofore used.

Auxology or Bathmology.

Mr. Buckman and Bather, both well known for their original and instructive researches on Paleozoology in England, have recently in a joint paper under the title of »The Terms of Auxology«[1] justly criticised the nomenclature employed in my papers to designate the stages of growth and decline in the individual. They have also proposed in view of the correlations which have been shown to exist between the transformations that occur in the stages of development and decline in the individual and those that characterize the evolution of the group to which it may belong, to designate the study of these correlations by the new term »Auxology«. This term is open to the objection that it is derived from αὔξη, meaning simply progressive growth up to and including the adult stages and, although in common with others I have felt that it has claims to be retained, there are good reasons why it should be restricted in application, if adopted, to researches upon growth. I have placed two terms at the head of this chapter partly because I have not had time to consult the proper judges, physiologists, and obtain their decision, and partly because I am undecided in my own opinion.

Cope in his »Method of Creation of Organic Forms«[2] used the therm Bathmism from Βαθμός, meaning a step or threshold, to designate growth force and it is therefore questionable whether the term

[1] Zool. Anz. No. 405. p. 406. 1892.

[2] Proc. Am. Phil. Soc. Dec. 1871 and »Origin of the Fittest«, p. VIII, etc.

Bathmology should not be substituted for Auxology in order to give uniformity to the nomenclature.

It is not necessary to discuss this here and the facts are merely mentioned to call attention to this question and bring out expressions of opinion.

Dr. C. S. Minot, who has given the first demonstration of the fundamental law of growth[3], has shown that the common notions with regard to the action of this force in organisms are erroneous. His plotted curves of the actual additions in bulk of the body by growth during equal intervals of time in guinea pigs show that these increments are in steadily decreasing ratio to the increase of weight of the animal from a very early age. He was so much impressed by these facts that he characterized the whole life of the individual as a process of senescence or growing old.

Naturalists have as a rule understood the differences between the organic molecular increase that takes place within cells which is the simplest form of growth, and that which follows this and builds up the tissues of the body by the division of cells. Both of these processes, although distinct from each other, result in additions to the bulk of the whole body of the organism and come properly under the head of growth. But while both are thus constructive so far as the body is concerned, only one can be considered constructive or anabolic while the other is essentially destructive or catabolic so far as the cell itself is concerned.

The function of nutrition and the nature of the organic structure are the two essential factors of growth, and this term, i. e. growth, also obviously applies to the morphology of metabolism, consisting of intra-cellular increase, or anabolism, and cellular development, or catabolism, and the phenomena resulting from the alternating action of these in ontogeny. This at once shows that growth is not simply progressive addition to the bulk of the body, since the multiplication of cells by fission is in itself catabolic or developmental so far as the cells are concerned. Further than this the ultimate results of catabolism are of the nature of reductions as is shown by Minot's work, by Maupas's observation on the old age of the agamic cycle in Infusoria, and the results of late researches on amitosis in cellular fission. These and the actual reduction of the body taking place in extreme senility show, that the term growth covers decrease in bulk due to development and use, as well as increase.

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[3] »Senescence and Rejuvenation«. Journ. Phys. XII. No. 2. 1891 and address on »Cert. Phen. of growing old«, Am. Assoc. Adv. of Sci. XXXIX. Aug. 1890.

When one passes beyond this and attempts to deal with the characteristics of ontogeny or phylogeny he at once finds himself in the presence of other forces, such as heredity and other processes namely, the acquisition of new characters and the renewal of the powers of growth in nuclear substances by means of conjugation.

The manifestation of growth energy in brief arises from two factors, or at any rate, is always found associated with two, a living organism and assimilation of nutritive matter, and is an obvious result of their union.

Genesiology.

The term heredity has been used in two senses, one expressing the results of the action of an unknown force which guides the genesis of one organism from another and a second in which it implies the force itself. Clearness of statement demands that some other term than heredity should be used and I consequently proposed to designate the study of the phenomena by the term Genesiology from Γένεσις, meaning that which is derived from birth or descent, this force itself as genetic force, and the principle of heredity thus becomes genism.

The continuity of the same element in the agamic division of unicellular bodies as in Protozoa makes it comparatively easy to explain the transmission of likeness, but this is growth of the ontogenic cycle. Maupas shows this clearly and continually speaks of the growth, full grown virility, and senility of his generations of unicellular, agamic protozoans. In fact they are obviously in a disunited form the equivalent of the colony of protozoans and secondarily, although more remotely, the equivalent of the single metazoan, or individual, which is essentially a cycle of agamic cells reproducing by fission.

While this likeness of agamic daughter cells to the original agamic mother cell which has disappeared in them may be considered a manifestation of heredity, it is also a form of growth and readily separable from the more complicated relations of organisms produced by conjugation of two forms. When the transmission of likeness is complicated with the effects of conjugation the difficulties increase until finally in the bodies of the metazoa they culminate in a problem of surpassing difficulty. Heredity is as plainly written in the life history of the Protozoan and in the growth of cells, in the tissues in the budding of the metazoa and the parthenogenesis, as in these more complicated forms, but the phenomena of transmission occurring after conjugation can be separated from growth and considered upon entirely distinct lines.

The theories offered show this. Thus the corpuscular theories, whether gemmules or biophors or pangenes are assumed, assert the

need of minute bodies for the transmission of characters, while on the other hand the dynamic theories, more in accord with physical phenomena assume that there is a transmission of molecular energy through growth and some of these views support Hering's theory of what may be called mnemegenesis. Namely, that heredity is a form of unconscious organic memory and this from my point of view is the only satisfactory one yet brought forward.

Heredity is obviously manifested for the most part in the developmental results of growth and appears chiefly in the cytoplasmic structures which Dr. Minot so clearly places before us as constantly increasing with age while the comparative size of the nucleus which represents the power of growth force decreases. Whether this be granted or not, it can hardly be denied, that, in describing the development of organisms along ontogenetic and their evolution along phylogenetic lines we are dealing with cycles of progression and retrogression which are quite distinct from the growth of the body as determined by the laws that govern its increase and reduction in bulk and that one cannot describe the study of both series of phenomena under the same general term without danger of confusion.

Genism, in brief, is the transmission of likeness from one ontogenic cycle to another of the same species. It appears to be due to the same factors as the perpetuation and rejuvenescence of the cycles themselves, namely, the union of two forms of distinct ontogenic cycles of the same species or kind.

Ctetology[4].

Weismann and his supporters deny that ctetetic or acquired characters are inheritable, but it is safe to make the assertion that this will not be maintained by the students of Bioplastology. Within the limits of my own experience in placing the genetic relations of varieties and species of fossils Cephalopods and other groups through geologic time, although I have tried to analyze the behavior of all kinds of characteristics, I have failed to find any such distinctions. If Weismann's theory is true it ought to be practicable to isolate in each type some class or classes of modifications that would be distinguishable by the fact that they were not inherited.

The only known cause of modification as demonstrated by the suitability of variations in existing characteristics, and by the more direct demonstration of experimentation, is the physical forces of the surroundings. These certainly have the power to originate modifi-

[4] Κτητός, something acquired.

cations either through their assumed direct action upon the growth of the parts, or trough their power to excite internal reactions and consequent modifications of parts and organs.

It is certainly not a very acute analysis of the facts which attributes to external causes exclusive power in producing modifications in many cases as has been largely done by experimental zoologists. For example, Brauer and the author have both pointed out this defect in the accepted explanations of the famous Schmankewitsch experiments upon *Artemia*, and the same may be said of the explanations of all experimenters who do not take into account the reactions of the organisms themselves. I mean here not simply the passive structural organization but the active internal reactions usually called effort by the Neo-Lamarckian school. The use of the word effort is, however, misleading, since it has inseparable association with consciousness, and I have suggested entergogenesis, entergogenism, and entergogenic from Ἐντός, within and Ἐργόν, work or energy.

The physical forces of the surroundings must act through medium of entergogenic movements and this is shown clearly in the nature of modifications produced which are extra growths, substitutions of characteristics due to changes of functions etc. or partial or absolute obliteration of these due to the failure of genetic force to repeat characteristics in the presence of opposing influences and superimposed characteristics as in accelerated development.

Ctetology should also however, include the study of the action of physical forces when they either actually do produce direct effects upon organisms or may be assumed to act in this way. Changes in light, food, heat and moisture may cause modifications that cannot be included under the head of entergogenic reactions without danger or confusion.

Maupas gives exceedingly instructive examples of this class and quotes other authorities who have investigated these effects in Protozoa.

Beddard gives a number of examples of such modifications in his »Animal Coloration« and Semper has also discussed the same subject more extensively in his »Natürlichen Existenzbedingungen der Thiere[5].«

The use of the term entergogenesis makes it practicable to indicate the essential distinction existing between the modifications produced through the mediation of internal forces and those arising as the direct results of the action of external forces by means of the term ectergogenesis and ectergogenic.

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[5] Translation by Minot, MacMillan, 1892.

These explanatory remarks serve to show that Ctetology is a branch of research which needs to be isolated from researches upon growth and Genesiology, since it is devoted to the study of the origin of acquired characteristics and therefore necessarily considers all of the internal reactions of the organisms in response to the action of physical forces, as well as the more obscure reactions of structures which are produced solely by (or supposed to be produced by) the direct physical or chemical action of external physical forces.

Bioplastology.

The separation of Auxology (or Bathmology), Genesiology, and Ctetology show also that the study of the correlations of ontogeny and phylogeny to be distinct from either of these, and this branch of research can be designated by the term Bioplastology from Βίος, life, and Πλαστός, meaning moulded or formed[6].

To sum up in a few words the rather ambitious aims of this comparatively new recruit in the army of investigation, it aspires to show that the phenomena of individual life are parellel with those of its own phylum and that both follow the same law of morphogenesis, that not only can one indicate the past history of groups from the study of the young, and obviously the present or existing progression or retrogression of the type by means of the adult characters of any one organism, but that it is also possible to prophecy what is to happen in the future history of the type from the study of the corresponding paraplastic phenomena in the development of the individual.

Whether these claims are well founded or not the nomenclature to be employed is a matter of importance and should be accurate, appropriate, and convenient for those who are interested in this work,

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[6] Bioplasm, bioplast, bioplastic have already been used by Beale and others for the living cell and its contents but the term »Bioplastology« has not been used nor have the names proposed by Beale been generally adopted. If they were Bioplasmology would cover the requirements of students of such phenomena and there is already in use Plasmology with about the same meaning, and Histology for the descriptive side of the study of cellular structures.

Biogeny has been used in extra scientific literature by Fiske with the same meaning as Bioplastology and Haeckel has named the law of embryonic and ancestral correlation the law of biogenesis, but there is a strong objection to both of these. Biogenesis is the name given to the theory of the origin or genesis of life from life in contra-distinction to the assumption of spontaneous generation, or abiogenesis and has a well established place in scientific literature. Therefore while the law of correlation of the stages of development and those of the evolution of the phylum, may, if one chooses, be called a law of biogenesis, it is more accurate to consider it a law of correlation in Bioplastology or better still the law of palingenesis or regular repetition of ancestral characters which exactly expresses what the discoverer Louis Agassiz saw and described.

and this abstract has been written in large part as a contribution towards this object.

(Schluß folgt.)

II. Mittheilungen aus Museen, Instituten etc.

1. Zoological Society of London.

6th June, 1893. — The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May 1893, and called special attention to a young Water-Buck (*Cobus ellipsiprymnus*), born May 4th, 1893, being, so far as was known, the first Antelope of this species that has been bred in captivity. — Mr. Walter Rothschild, F.Z.S., exhibited and made remarks on an egg of the Duckbill (*Ornithorhynchus anatinus*), taken from the pouch of the mother; the leg-bones and egg of an extinct bird of the genus *Aepyornis* from South-west Madagascar; and series of Lepidopterous Insects from Jamaica and from the Bolivian Andes. — Mr. Sclater exhibited and made remarks on some skins and skulls of Mammals obtained in the Shiré Highlands by Mr. H. H. Johnston, Mr. B. L. Sclater, Messrs. Buchanan, and Mr. Alexander Whyte. — A communication was read from Messrs. F. E. Beddard and F. G. Parsons containing notes on the anatomy and classification of the Parrots, based on specimens lately living in the Society's Gardens. — Mr. Sclater called attention to two front horns of an African Rhinoceros belonging to Mr. F. Holmwood, which were stated to have been brought by native caravans from the district of East Africa, south of Lake Victoria Nyanza. They were remarkable for their great length and extreme thinness. — A communication was read from Mr. R. Lydekker containing an account of a collection of Bird-bones from the Miocene Deposits of St. Alban, in the Department of Isère, France. The more perfect specimens were referred mostly to new species (*Strix Sanctialbani*, *Palaeortyx maxima*, *P. grivensis*, and *Totanus Majori*), while others were regarded as undeterminable from their fragmentary condition. — Mr. G. A. Boulenger read a paper describing new Species of Reptiles and Batrachians, based on specimens lately obtained in Borneo by Mr. A. Everett and Mr. C. Hose. — P. L. Sclater, Secretary.

2. Linnean Society of New South Wales.

May 31st, 1893. — 1) Descriptions of new Australian Lepidoptera, with additional Localities for known Species. By T. P. Lucas, M.R.C.S. — 2) Botanical. — 3) The Silurian Trilobites of New South Wales. Part II. The Genera *Pröetus* and *Cyphaspis*. By R. Etheridge, jun., and John Mitchell. — 4) Description of a new *Murex* from South Australia. By John Brazier, C.M.Z.S., F.L.S. — Mr. Brazier exhibited a specimen of the South Australian *Murex polypleurus*, n. sp., described in his paper, a species which in the past, by the late Mr. G. F. Angas and other authors, has been confused with *M. pumilus*, A. Ad., from the China Sea, and Darros Island, Amirantes. Also a fossil specimen of *M. octogonus*, Q. and G., from New Zealand. — Rev. J. Milne Curran read a note recording the presence of a fossil Buprestid beetle in an earthy limonite at Inverell, N.S.W. The insect is represented by a portion of a metallic green elytron, and it is associated with Miocene fossil leaves and a species of *Unio*. He also showed